

## WORLD NUMBERS OF BUTTERFLIES

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**ABSTRACT.** World butterflies number about 17,280 species representing described taxa that have not been synonymized, and are currently grouped into 1855 genera, 35 subfamilies, and 7 families. Butterflies constitute only 9-12% of all lepidopteran species.

**Additional key words:** faunal realms, genera, subfamilies, families, conservation.

Published estimates of the total number of butterfly species in the world range from 7700 (Kirby 1872) to 20,000 (Fox & Fox 1964, Vane-Wright 1978, Landing 1984), although most authors do not cite specific sources used in forming their estimates. An exception is Robbins (1982), whose world total of 15,900-18,225 was compiled by faunal realms, although he largely estimated numbers for the Neotropics and Orient and did not adjust for the percentage of species that extend into two or more realms. Affinities between the west Palearctic and Ethiopian butterfly faunas are indeed minimal (De Jong 1976), but a modest amount of exchange (perhaps 5-10%) is to be expected across the Nearctic-Neotropical, east Palearctic-Oriental, and Oriental-Australian frontiers (cf. Schmidt 1954, Rapoport 1971). The total number of butterfly species, coupled with the land area they occupy, measures butterfly richness and density on a global scale, of interest to ecologists and conservationists. Here I present a current estimate of butterfly species numbers as part of the continuing effort to determine just how many species of living organisms there are on earth (cf. Jones 1951, May 1988, Wilson 1988).

### METHODS

Species totals for most butterfly subfamilies (Table 1) were obtained from the recently published catalogs of Bridges (1988a, 1988b, 1988c, 1988d), which counts species that extend into two or more realms only once. Some of the Nymphalidae subfamilies, however, have not been recently cataloged. The number of Nymphalinae species was estimated by multiplying its number of genera (181) by 14 (the average number of species per genus in Danainae *s. str.*, its close relative) to yield ca. 2500 species. This figure compares well with the roughly 2700 species I estimate for Nymphalinae using faunal lists. Numbers of species for Satyrinae and Morphinae are also estimates (see footnotes 6 and 7, Table 1). For the Danainae and Brassolinae, species numbers are based on figures provided by researchers currently revising these groups (see footnotes 4 and 8, Table 1).

## RESULTS AND DISCUSSION

The grand total of described butterfly species is about 17,280 (see Table 1). This total is higher than the 13,000 estimate of Owen (1971), the 14,750 estimate of Scott (1986), the 15,600 low estimate (when Hesperidae are included) of Ehrlich and Raven (1964), and the 15,900 low estimate of Robbins (1982) and is lower than the world maximum estimates of 18,225 (Robbins 1982), 18,600 (Ehrlich & Raven 1964), and 20,000 (Fox & Fox 1964, Vane-Wright 1978, Landing 1984). The total is only 945–1320 species less than the maximum estimates of Ehrlich and Raven (1964) and Robbins (1982). Bridges (1988d) lists 1855 world genera, though, of course, generic limits are largely subjective. For example, Bridges' (1988d) figure of 1326 genera (excluding skippers) sharply contrasts with the estimates of 730–930 and 953 genera given by Ehrlich and Raven (1964) and Scott (1986), respectively. The number of described species of butterflies in the world constitutes 9–12% of all described Lepidoptera species, whose total numbers are estimated to be 150,000–200,000 (Kristensen 1984).

Subfamilies with the greatest numbers of species are (in descending order) Nymphalinae, Satyrinae, Theclinae, and Hesperinae (greater than 2000), followed by Pyrginae, Polyommatainae, and Riodininae (greater than 1000). Baroniinae, Curetinae, Styginae, Pseudopontiinae, Libytheinae, and Calinaginae are morphologically archaic subfamilies each containing only one or two genera and fewer than two dozen species. Three families (Hesperidae, Lycaenidae, and Nymphalidae) comprise 82% of all butterfly species and are the only families to use both dicots and monocots extensively as larval hostplants (cf. Ehrlich & Raven 1964). About 30% of all butterfly species feed only on monocots, especially the Trapezitinae, Hesperinae, Megathyminae, Satyrinae, Morphinae (in part), and Brassolinae. The world species richness of butterflies, 17,280, when divided by 128,811,340 km<sup>2</sup>, the total land area of the earth excluding Antarctica and inland waters, yields an average density of 0.000134 species per km<sup>2</sup>. Roughly two-thirds of the species occur in the tropics.

The numbers of butterfly species presented here represent described taxa that have not been synonymized. Only in the best-known family, Papilionidae, is it possible to estimate closely the true number of species. Subfamilies like Theclinae, Polyommatainae, Riodininae, Nymphalinae, Calinaginae, and Satyrinae are so poorly known taxonomically that their counts probably inflate their actual species totals by including many unsynonymized names. Most other subfamilies fall somewhere between these two extremes. Cladistic analysis should aid in identifying monophyletic subfamilies in Nymphalidae but has not yet been per-

TABLE 1. Numbers of butterfly species by family and subfamily.

Family and subfamily	No. species	References
Hesperiidae	3592	
Pyrginae	1193	Bridges 1988a
Coeliadinae	80	Bridges 1988a
Pyrrhopyginae	155	Bridges 1988a
Trapezitinae	67	Bridges 1988a
Hesperiinae	2048	Bridges 1988a
Megathyminae	49	Bridges 1988a
Papilionidae	566	
Papilioninae	511	Bridges 1988b
Parnassiinae	54	Bridges 1988b
Baroniinae	1	Bridges 1988b
Lycaenidae <sup>1</sup>	4089	
Lipteninae	527	Bridges 1988c
Poritiinae	52	Bridges 1988c
Liphyrinae	20	Bridges 1988c
Miletinae	111	Bridges 1988c
Curetinae	22	Bridges 1988c
Theclinae	2128	Bridges 1988c
Lycaeninae	97	Bridges 1988c
Polyommatainae	1132	Bridges 1988c
Riodinidae	1366	
Hamearinae	97	Bridges 1988c, Robbins 1988a
Euselasiinae	154	Bridges 1988c, Robbins 1988a
Riodininae	1114	Bridges 1988c, Robbins 1988a
Styginae	1	Robbins 1988a, 1988b
Pieridae	1215	
Pseudopontiinae	1	Bridges 1988b
Dismorphiinae	95	Bridges 1988b
Pierinae	905	Bridges 1988b
Coliadinae	214	Bridges 1988b
Libytheidae	12	
Libytheinae	12	Shields 1985
Nymphalidae	6440	
Nymphalinae <sup>2</sup>	2500	Bridges 1988d, see text
Argynninae <sup>3</sup>	155	Warren 1944, 1955; dos Passos & Grey 1945; Grey <i>in litt.</i> ; Common & Waterhouse 1972; Brown 1981
Acraeinae	240	Pierre 1987
Calinaginae	16	Oberthur 1919, 1922; Wu 1938
Danainae <sup>4</sup>	462	Ackery & Vane-Wright 1984; Drummond & Brown 1987
Apaturinae <sup>5</sup>	431	Stichel 1938, 1939; Le Moult 1950; Comstock 1961; van Someren 1975
Satyrinae <sup>6</sup>	2400	Gaede 1931; L. D. Miller, pers. comm.
Morphinae <sup>7</sup>	155	D'Abreu 1984; Parsons 1984
Brassolinae <sup>8</sup>	81	Stichel 1932
World total	17,280	present study

<sup>1</sup> Eliot (*tn litt.*) estimates 44 species of Poritiinae and 15 species of Curetinae based upon his unpublished research, and he notes that the Neotropical Theclinae species listed by Bridges have many synonyms but also that hundreds of discovered but undescribed species of Theclinae exist.

<sup>2</sup> Includes the tribes Ageroniini (=Hamadryini), Biblidini (=Didonini, Ergolini, Eurytelini), Coeini (=Aganisthini,

formed; preliminary analysis indicates that some conventional nymphalid subfamilies are polyphyletic (DeVries et al. 1985).

The world number of species or "species richness" obscures much of the interesting ecological diversity of butterflies. Many polytypic species, e.g. in *Heliconiini* and *Ithomiinae*, have populations that differ markedly in behavior, food plant relationships, and color patterns.

It is instructive to compare butterflies with birds, taxonomically the best-known invertebrate and vertebrate groups. At the level of species, "The taxonomy of no other group of animals is as mature as that of birds" (Mayr 1982:292). Kirby (1872) estimated that the number of species of butterflies and birds was about the same. By the early twentieth century, Sharpe recognized 18,937 bird species (including fossil species and all subspecies as full species), a figure that dropped to 10,000–16,000 by the early 1930's (Mayr 1988). By 1935 careful zoogeographic and systematic research had reduced the estimated number of birds to 8500 (Mayr 1946). Today's best estimate of the number of bird species is ca.  $7000 \pm 200$  (Mayr 1988), which is only 40% of the number of butterfly species reported in the present study. Since 1935 only about 140 valid new bird species have been described, with the reduction in the number of species names (by more than 60% over the past 80 years) primarily coming about by revisional downgrading of geographical isolates of polytypic species from the rank of species to subspecies (Mayr 1988). This same process is now occurring in butterflies, but so far it has progressed to a far lesser extent than it has in birds. Unlike birds, however, many new species of butterflies are still being discovered and described each year, particularly from the tropics.

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Coloburini, Gynaeciini), Cyrestini (=Marpesiini), Epicaliini (=Callicorini, Catagrammini, Catonephelini, Dynamini, Epiphilini, Euniciini), Limenitidini (=Abrotini, Adelphini, Bebearini, Chalingini, Euthaliini, Neptini, Neurosigmatini, Parthenini, Pseudacraeini), Nymphalini (=Araschniini, Cynthini, Diademini, Doleschallini, Euphydryini, Hypolimnini, Junonini, Kalimnini, Melitaeni, Phycioidini, Vanessini), Pseudergolini.

<sup>3</sup> Includes *Heliconiinae*, *Cethosini*.

<sup>4</sup> Includes *Ithomiinae* (=Ithomiini, Tellervini). Drummond and Brown (1987) cite 305 species of *Ithomiinae* and include only one species of *Tellervo*, although Ackery (1987) claims there are 6. Other species estimates for *Ithomiinae* are extremely variable: ca. 300 (Drummond 1986), 318 (Mielke & Brown 1979), 349 (Fox 1953), ca. 400 (D'Abrera 1984), and 518 (Bryk 1937). Haensch (1909) in Seitz's *The Macrolepidoptera of the World* listed 883 named forms, most of which he treated as species. The best figure is 305 species, based largely on Brown's ongoing study of ithomiine phylogeny (*vide* Drummond). The *Ithomiinae* admirably show the gradual reduction in number of species as a group becomes better known (dropping by nearly two-thirds over the past 80 years), largely as a result of a growing recognition of the many widespread polytypic species in this group. There are 157 species of *Danainae* (*s. str.*) (Ackery & Vane-Wright 1984).

<sup>5</sup> Includes *Charaxinae*.

<sup>6</sup> Miller (1968) estimated between 2500–3000 *Satyrinae* species (including *Brassolinae*), but he now feels this is too high. His new estimate (*pers. comm.*) is about half again as many as in Gaede (1931). As Gaede listed 1605 species, the new estimate is ca. 2400 species.

<sup>7</sup> Includes *Amathusiinae*. Parsons (1984) estimates there are ca. 100 species of *Amathusiinae*. *Morphinae* now includes the Neotropical genera *Morpho*, *Antirrhea*, and *Caerois* (DeVries et al. 1985). D'Abrera (1984) lists 31 species of *Morpho*, 21 *Antirrhea*, and 3 *Caerois*. Smart (1977) estimates about 80 species of *Morpho*, probably too many (*cf.* D'Abrera 1984).

<sup>8</sup> Smart (1977) lists 75 species. Preliminarily there are 86 species according to Casagrande (*in litt.*) who is currently revising the subfamily.

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## THE SPHINGIDAE (LEPIDOPTERA) OF BAJA CALIFORNIA, MEXICO

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**ABSTRACT.** Baja California is a rugged, mostly xeric peninsula situated along the northwestern coast of Mexico. With the exception of butterflies, the lepidopterous fauna of this region is poorly studied. Twenty-six species of Sphingidae are known from the peninsula, including one endemic species, *Sphinx xantus* Cary, and three endemic subspecies, *Manduca rustica cortesi* (Cary), *Pachysphinx occidentalis peninsularis* Cary [revised identification], and *Callionima falcifera guaycura* (Cary) [revised identification]. For each of the 26 species, information is presented on peninsular distribution, flight period, and possible larval host plants.

**Additional key words:** peninsular effect, host plants, distributions.

The peninsula of Baja California (or Lower California; here termed simply "Baja California") is situated along the northwestern coast of México, extending southeasterly approximately 1300 km from the international border to its tip at Cabo San Lucas. It is bordered by the state of California (Alta California) on the north, the Pacific Ocean on the west, and the Sea of Cortés (Gulf of California) on the east (Fig. 1). The mainland Mexican states of Sonora and Sinaloa lie to the east of the gulf. Much of the peninsula is a low lying desert. However, in the north are two major mountain ranges, the Sierra Juárez and the Sierra San Pedro Mártir, which represent extensions of the Peninsular Ranges of southern California. Two significant ranges occur in the southern third of the peninsula: the Sierra de la Giganta, running parallel to the eastern coast, and the Sierra de la Laguna in the center of the southern tip. Politically the peninsula is divided at the 28th parallel into a northern state, Estado de Baja California (here termed Baja California Norte to avoid confusion), and a southern state, Estado de Baja California Sur (Baja California Sur).

Although comparatively depauperate, the lepidopterous fauna of Baja California is nonetheless unique and diverse, primarily as a consequence of the nearly 10° range in latitude the peninsula embraces, and its relative isolation from mainland México. Except for butterflies,

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